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Harvesting a Rod-row of Soybeans for Forage

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THE PURPOSE of this bulletin is to report the results of certain soybean investigations, to make recommendations in regard to varieties, and to give cultural directions for producing the crop under West Virginia conditions.

The soybean variety test has been carried on for ten years on the Agronomy farm of the Experiment Station at Morgantown and for a period of nine years at the Lakin Experiment farm in Mason County. It is felt that the results obtained from these variety tests are indicative of the relative yielding ability of the various varieties tested and should be of considerable aid to the farmer who is growing or considering the growing of soybeans.

COMMERCIAL IMPORTANCE

The soybean is an annual legume, native to southeastern Asia. The first introductions were made into the United States in 1804, but it is only within the last decade that this crop has become of much importance. Most of the acreage today is devoted to forage production. In certain localities, however, particularly within the cornbelt, seed production has proved profitable.

The acreage devoted to soybeans in the United States has shown a phenomenal increase since 1920. One hundred eighty-six thousand acres of soybeans were grown in the United States in 1921, with West Virginia reporting less than 1000 acres. In 1930 the acreage for the United States had increased to 3,500,000, while West Virginia reported more than 35,000. Such an increase in acreage for any one crop, in spite of the general curtailment of agricultural crop acreages within this state, indicates that the crop in question is contributing something of real value to those who grow it.

This increase in acreage is no doubt due in part to the fact that the soybean plant can be utilized in a number of ways. Some of the common uses follow:

HAY: Soybean hay of excellent quality can be made on most farms without the expenditure of money for new equipment and machinery. When fed to livestock, especially dairy cows, the hay is prized for its high protein content. There is a good demand for this legume hay and a grower rarely finds difficulty in disposing of surplus.

GREEN MANURE: Soybeans are vigorous growers and aid in building up the nitrogen and organic content of a soil. This is especially true when the plants are properly inoculated, since much of the nitrogen added to the soil when the tops and roots decay represents a gain from the atmosphere.

Crop Rotation: Many farmers who realize the value of a legume in the general rotation include soybeans in the cropping scheme. The short rotations into which the annual soybean crop can be fitted enable one to grow a legume crop more frequently on a given area than would be possible with crops of clover or alfalfa, which require two or more years.

Seed: In certain areas of the United States, especially in the cornbelt states, the production of soybean seed has been found to give profitable returns. At the present time much of the seed produced is used for planting, although the amount utilized in various industrial and manufacturing processes is increasing each year. These uses range from the production of oil cake for stock feed and oils for paints and varnishes to the many new preparations designed for human consumption.

LIME AND FERTILIZERS

Soybeans are more tolerant of acid soil than red clover, alfalfa, and many other agricultural crops. This fact has given rise to the feeling on the part of some growers that lime is not necessary for soybeans.

A rotation experiment in progress at the Lakin Experiment farm, where the yields of certain crops are compared on limed and unlimed series, shows five-year average yields of 23.1 and 17.4 bushels of seed and 1.12 and 0.98 tons of forage, respectively, for the limed and unlimed series. Although soybeans are tolerant of acid soil conditions the increase in yield of both seed and forage indicates a marked response to lime.

The West Virginia Station recommends 200 to 300 pounds of an 0-14-6 fertilizer for soybeans grown on sandy soil without manure and other legumes in the rotation. With silt or clay loam soil an application of 200 to 300 pounds of superphosphate alone is recommended. Nitrogenous fertilizers are unnecessary when the plants are properly inoculated, since the free nitrogen of the air is assimilated for use by the plant. On soils of low fertility a light application of a readily available nitrogenous fertilizer may be found advantageous in starting the crop.

SOIL AND CLIMATIC CONDITIONS

The climatic adaptations of the soybean are about the same as for corn. After the plants are well started they can withstand short periods of drought without serious injury, while a wet season does not seem to retard seriously the development of the crop. The period of germination is the most critical in the life of the plant, and excessive drought or moisture will prove most injurious at that time. Soybean plants are less susceptible to frost than cowpeas or corn.

Many of the most important varieties now being grown have been introduced from Asiatic countries. Some of these varieties have been found to fill certain climatic requirements. For this reason they are being grown in rather restricted areas.

The number of days required for maturity varies from 90 t nearly 200, while response to cultural treatment and soil fertilit seems to show equally wide variation.

The soybean prefers a fertile loam or sandy loam but does wel on any soil that will grow corn satisfactorily. Like other farm crop soybeans do best when planted in a well-prepared seedbed. In gen eral the land should be prepared as for corn. A firm seedbed with loose covering of fine soil is found to give most satisfactory stands It is essential to have the surface free from clods, especially if th soybeans are seeded broadcast. If the seedbed has been thoroughly and carefully prepared it is often possible to follow the soybeans with the next crop in the rotation by disking the soybean stubble instead of plowing it under. This is especially true when such crops as wheat, rye, or alfalfa follow the soybeans.

INOCULATION

Soybeans, like other legumes, are able to utilize the free nitrogen of the air by the action of bacteria in the nodules on the roots of the plants. Many cases of success or failure in the growing of soybeans can be traced to the presence or absence of these bacteria.

Soybeans will make a satisfactory growth in a fertile soil in the absence of proper inoculation, but the nitrogen for growth is taken from the soil rather than from the free atmospheric nitrogen. If the fertility of the soil is low and available nitrogen is somewhat deficient, the leaves of uninoculated beans are pale yellow, whereas inoculated beans grown under similar conditions have a dark-green color and exhibit much more vigorous growth.

Natural inoculation will occur in a field for several years after the removal of inoculated soybeans. If the soil reaction is neutral or slightly alkaline, this time is greatly prolonged, but an acid soil seems to shorten considerably the period over which the bacteria remain active.

Two methods in general use for the inoculation of soybeans may be termed (1) the soil method and (2) the pure-culture method.

The soil method is probably the cheapest and easiest for the general grower. It can be carried out as follows: Obtain a sample of soil (a quart for each bushel of beans to be seeded) from one to three inches in depth from near the roots of soybean plants which are known to have been inoculated. This soil should be allowed to dry slowly, preferably in the shade, and sifted to remove the coarse soil particles. The soybeans should be dampened by sprinkling lightly with water, stirring until the seedcoats are moistened, and dusting with the fine screenings of inoculated soil. During the application of the water and soil the beans should be thoroughly stirred to make certain that each seed receives a film of water and a coating of dust. The seed may be planted immediately or, if necessary, permitted to dry somewhat before being seeded.

The method just described is commonly spoken of as the dry-soil inoculation. A variation of this procedure, known as the wet-soil

method differs in that a thin muddy paste is first made from the inoculated soil. The seed is dipped into this muddy water, allowed to dry, and seeded. This method seems to give no better inoculation and involves considerably more time and work, since the wet beans must be stirred while drying, or difficulty will be encountered from the germinating beans.

A third variation of the soil inoculation method is similar to the dry method first described, except that the beans are not moistened, and more soil is used. Approximately one peck of soil for each bushel of beans is obtained, pulverized, and placed in the drill box on top of the beans. The inoculated soil and beans are drilled together.

The pure-culture method consists of inoculating the soybean seed with a pure culture of the bacteria which produce the root nodules. Nearly all commercial seed houses are equipped to supply sufficient pure cultures of bacteria for the amount of seed purchased. Directions for use of the pure culture inoculum are sent with the container.

TIME AND METHOD OF SEEDING

Soybeans are usually planted just after corn-planting time. This will insure warm soil and if the seedbed has been thoroughly prepared and is free from weeds, one may expect a good stand. West Virginia Bulletin 227 reports data obtained when soybeans were planted at approximately 15-day intervals from May 5 to July 10. The average yield over a 3-year period was slightly in favor of the early plantings, but the corresponding hay was coarse and weedy. On the other hand the hay produced from the late plantings was not only low in yield but also difficult to cure into a satisfactory feed. The results indicate that the optimum time to plant is between May 15 and June 15 for West Virginia conditions. These findings at West Virginia are in general agreement with reports from other experiment stations located in the same general latitude.*

The method of seeding may differ somewhat, depending upon the use to be made of the crop. If soybeans are to be grown for seed the common practice is to plant them in rows of sufficient width to permit cultivation. These may vary from 28 to 42 inches. The most suitable width seems to depend upon the implements available for cultivation and culture of the plants. Some growers find that by closing certain of the openings, an ordinary grain drill can readily be converted into a bean drill which will give rows of any desired width. If the larger openings are used there is less danger from splitting the beans. Corn planters may be used for seeding the beans alone or in mixtures with corn. If corn and soybeans are seeded together the

*Iowa Bulletin 228 reports May 24 and May 10 as the optimum dates for seed and forage yield, respectively. Virginia Bulletin 235 gives May 11 as the optimum date for planting beans for hay or forage. Ohio Bulletin 384 reports May 19 and June 12 as the best dates for seed and forage, respectively. The Missouri Station reports June 1 to June 15 as giving best yields under their conditions.

seed mixture should be stirred frequently for uniform distribution. As a general rule the stand of both crops is not as uniform when they are seeded together as when they are drilled separately.

When soybeans are grown for hay or green manure the most satisfactory method of seeding is in close drills, although broadcast seeding gives satisfactory yields and is practiced rather generally throughout the cornbelt states. The rate of seeding depends somewhat upon the variety of soybeans grown and the use to be made of the crop. West Virginia Bulletin 227 gives the data obtained during the years 1921-25, inclusive, when beans were drilled at the rate of 4, 5, 6, and 8 pecks per acre. The conclusion drawn is that with varieties with medium-sized seed such as Wilson, the best rate of seeding is 6 to 8 pecks per acre. The fine quality of hay with few weeds, along with a slightly higher tonnage, indicates this rate as the most desirable. When planted in rows and grown as a cultivated crop there seems to be no distinct advantage in heavy seeding. Yields reported by the Indiana, Iowa, Ohio, and Virginia Stations show no significant increases in yield of seed with rates of seeding varying from fifteen to thirty pounds per acre.

The Iowa and Virginia Stations have reported yields of hay from plots receiving various types of cultivation. The conclusions drawn point to a distinct advantage in favor of cultivation; this is not only indicated in yield but also in freedom from weeds. It is the practice at the West Virginia Station to cultivate the solid drilled plots with a spike-tooth harrow. The teeth should be slanted backward considerably to prevent injury to the seedlings. One should not cultivate the plants just as they are emerging because of the severe injury that may result. Cultivation should follow the drill row and may be continued until the seedlings are several inches high. It is found that such treatment is very effective in the control of grass and weeds.

SOYBEAN HAY MIXTURES

Soybeans make a very desirable hay mixture when seeded with 6 to 8 pounds of Sudan grass per acre. This combination has been recommended by the Iowa Station and has also proved to be the most desirable of four combinations grown at the West Virginia Station.

The Sudan grass—soybean mixture gives a hay of good quality and desirable yield and has the important advantage of ease of curing.

When grown for hay soybeans should be cut when the pods are well filled but before the leaves turn yellow and fall. Some growers prefer cutting when the seed in the pod is just beginning to form. Varieties differ greatly in their fineness of stem and ability to retain leaves. The most desirable hay types become woody if allowed to stand too long.

When cut for hay the plants should remain in the swath until well wilted. The curing process should then be completed in small cocks or windrows. If the hay has become too dry in the swath it

should be raked after a heavy dew to prevent excessive loss of leaves. During unfavorable weather conditions the curing process takes considerable time, but a good quality hay can be made by permitting the complete curing in small cocks. Wet or uncured soybean hay should not be stacked or put into the mow because of the danger of spoiling.

It has been the practice for some years on the Agronomy farm to establish alfalfa meadows after the removal of a soybean hay crop. If the seedbed is well prepared in the spring for soybeans the alfalfa can successfully be established by thoroughly disking the soybean stubble and seeding the alfalfa between August 1 and 15. When this practice is followed, 400 to 500 pounds of a mixed fertilizer carrying some nitrogen such as a 2-14-4 should be applied to the seedbed for alfalfa. By following this procedure one can get considerable cash return from the land and at the same time establish the alfalfa meadow under optimum conditions.

When soybeans are grown for seed the plants should be permitted to stand until the pods are ripe, but harvested before excessive loss from shattering has occurred. As a general rule the leaves will all be off before the seed is ripe. A grain binder makes a very satisfactory implement for harvesting the beans for seed. If the beans have been grown in rows the binder can handle two rows at a time. The cutting should be done while the plants are damp and tough in order to reduce shattering to a minimum. The beans should be placed in small shocks, and threshed when properly cured. Care in threshing should be exercised in order to prevent loss from cracked and broken beans. The removal of concaves with a greatly reduced cylinder speed will generally give good results with most threshers.

Beans should be thoroughly dry before being stored in large bulk since seed that is allowed to heat soon loses its viability and is of no value for seeding purposes.

The foregoing account is given in order to acquaint the prospective grower with the salient facts regarding the culture of this crop. The following section will introduce the experimental data upon which the choice of a variety should be made.

METHODS USED IN EXPERIMENTS

The experimental area on the Agronomy farm at Morgantown was treated with an application of superphosphate at the rate of 200 pounds per acre per year. Lime was applied as needed to maintain a favorable reaction for plant growth. The soybeans were not grown on the same area each year but appeared in their proper sequence in a more or less regular rotation which covered most of the tillable area of the Agronomy farm. The plots consisted of two rows, 18 feet long and 30 inches apart. During the first three years of this experiment the plots consisted of four rows, data being recorded only on the yields obtained from the center rows of the plots. It was felt that the two border rows were necessary in order to eliminate

border influence of adjacent varieties. As the result of a careful study made on the influence of adjacent rows of soybeans on one another,* it was found that the border influence of adjacent rows was negligible. Therefore the plot size was reduced to two rows in the later trials.

Each variety was grown in five plots systematically distributed over the experimental area and seeded by hand. The seeds were spaced approximately one inch apart in the row. The weight of seed per row was determined as the result of a germination test made on all varieties prior to seeding. At harvest the rows were reduced to 16 feet. When harvested for hay the green weight of one row of a variety was recorded. A weighed sample of the green material was taken from each harvested row and dried to determine the air-dry weight. The second row of each plot was permitted to stand until ripe; this was cut, placed in a burlap bag until thoroughly dry, and threshed on a small rod-row thresher. The seed obtained was then cleaned, weighed, and calculated on the basis of acre yield. General notes of agronomic interest such as height, coarseness of stem, days to mature, retention of leaves, and character of growth were recorded for each of the varieties in the experiment.

The experiments at Lakin were similar to those at Morgantown except for the year 1922, when the plots consisted of two rows approximately 40 feet in length.

EXPERIMENTS AT THE AGRONOMY FARM

Thirty-five varieties and pure-line selections of soybeans were included in the varietal experiments on the Agronomy farm. Nineteen of these varieties were grown for the ten-year period from 1921 to 1930, inclusive, while 16 varieties were grown for the six years from 1925 to 1930. All varieties were tested from the standpoint of both seed and forage yields.

The varieties listed in Table 1 are arranged according to rank as determined by their average yields. Column 2 shows the average number of days required to mature seed. It will be noted that these varieties can be arranged conviently into early, medium, and late groups. U. S. No. 36902, Manchu, Black Eyebrow, and Elton constitute the early varieties and require less than 130 days to mature seed. These four varieties rank second, fourth, thirteenth, and eighteenth in yield. The medium group requires between 130 and 145 days to mature seed and includes most of the varieties of this test. The late varieties require from 145 to 155 days to mature seed and include Mikado, Morse, Dixie, Lexington, Austin, Hahto, and Mammoth Yellow. Some of these varieties fail to produce a normal seed crop during certain seasons.

There seems to be no direct relation between the average number of days to mature seed and yield in the varieties compared. Haberlandt, a relatively late variety, ranks first, followed by U. S. No. 36902, an early variety. In general the late maturing sorts tend to

*Jour. Amer. Soc. Agron. Vol. 18, No. 7.

TABLE 1.—*Yield in bushels per acre and days to mature of soybean varieties grown on the Agronomy farm*

Variety	West Virginia No.	Ave. No. of Days to Maturity	Yield in bushels per acre										Ave. 1921-1930	Ave. 1925-1930
			1921	1922	1923	1924	1925	1926	1927	1928	1929	1930		
Haberlandt	5	145.6	36.9	20.2	34.2	26.7	23.3	36.8	19.4	31.8	30.6	15.1	27.5	26.2
U. S. No. 36902	26	127.5	36.6	26.5	36.3	25.5	23.8	30.3	16.5	32.9	24.4	18.6	27.1	24.4
U. S. No. 30745	24	136.3	36.6	24.3	27.8	26.1	23.6	31.5	18.6	38.0	25.0	15.9	26.8	25.5
Manchu	4	127.9	28.9	22.3	28.5	27.6	30.5	28.0	14.5	33.4	27.9	18.4	26.0	25.5
Wilson	9	132.3	28.8	24.0	27.2	25.5	22.3	28.5	19.9	34.8	27.5	18.6	25.7	25.3
Ohio 9016	18	133.0	29.1	23.2	30.1	19.7	23.5	37.2	16.4	36.8	26.6	14.0	25.7	25.7
Hamilton	19	140.9	30.5	23.1	34.9	22.6	21.1	34.7	14.7	32.3	29.3	13.2	25.7	24.2
Wilson (Check)	1	132.4	31.7	22.6	29.9	25.6	23.1	28.3	17.6	32.9	25.9	16.6	25.4	24.1
Peking Sel. I-21-8	16	135.3	36.8	20.5	24.2	22.9	20.8	29.2	18.1	31.1	30.7	18.5	25.3	24.7
Peking Sel. I-21-7	15	135.8	37.8	20.3	25.3	20.3	21.3	28.3	17.3	32.7	27.6	18.0	24.9	24.2
Wilson Sel. I-21-9	17	134.5	35.0	21.9	21.7	23.9	22.4	28.5	16.9	32.0	27.5	17.1	24.7	24.1
Virginia	10	141.5	34.9	21.0	23.2	23.1	21.4	27.8	19.9	28.2	27.9	15.9	24.3	23.5
Black Eyebrow	3	128.8	28.1	22.6	21.9	22.3	26.9	25.9	16.3	31.5	22.9	16.7	23.5	23.4
Medium Green	8	130.9	31.9	20.9	25.2	22.3	20.3	31.1	13.5	33.5	19.7	13.0	23.1	21.9
Peking Sel. I-21-5	14	135.6	33.8	17.8	22.5	18.4	20.2	26.7	17.1	29.1	28.5	17.2	23.1	23.1
Aksarben	23	137.4	26.9	18.9	32.4	24.5	21.2	30.2	15.1	24.3	21.7	16.6	23.2	21.5
Mikado	7	150.2	29.2	22.5	25.3	24.0	16.1	31.5	18.4	22.3	20.1	10.1	22.0	19.8
Elton	2	126.7	30.3	24.4	25.3	22.9	22.8	21.1	10.4	27.6	17.3	12.2	21.4	18.6
Peking	11	144.2	31.4	15.9	20.6	17.6	17.0	25.2	17.0	24.3	20.6	12.4	20.2	19.4
Morse	31	148.9	...	...	...	...	20.7	33.9	18.9	29.1	22.0	15.1	...	23.3
Hoosier	44	138.5	...	...	...	...	21.5	26.3	16.0	31.7	25.6	16.1	...	22.9
Dixie	46	150.2	...	...	...	...	19.3	26.7	19.1	32.8	25.2	11.8	...	22.5
Merko	38	140.3	...	...	...	...	22.6	26.7	18.1	28.5	21.8	14.2	...	22.0
Ebony	40	135.6	...	...	...	...	21.2	27.1	16.0	29.1	19.3	12.1	...	20.8
Lexington	39	151.1	...	...	...	...	18.0	30.0	17.0	22.5	19.3	13.5	...	20.1
Austin	34	152.5	...	...	...	...	17.0	27.3	17.4	23.1	21.7	12.6	...	19.9
Hollybrook	29	141.8	...	...	...	...	20.3	29.7	9.6	26.3	16.5	10.5	...	18.8
Wilson-five	33	138.3	...	...	...	...	17.8	24.1	14.7	22.9	19.3	13.6	...	18.7
Columbia	43	142.5	...	...	...	...	16.5	27.1	12.8	20.7	19.7	13.8	...	18.4
Midwest	37	146.1	...	...	...	...	20.0	25.9	11.6	24.3	17.8	10.6	...	18.4
Hahto	42	156.7	...	...	...	...	12.5	27.0	15.7	22.5	20.0	8.8	...	17.8
Chiquita	41	153.1	...	...	...	...	13.5	36.0	12.6	15.7	15.2	10.8	...	17.3
Haberlandt 38	36	151.0	...	...	...	...	10.5	34.4	10.4	21.5	13.0	9.0	...	16.5
Laredo	45	154.3	...	...	...	...	14.5	26.6	15.2	14.9	14.1	7.0	...	15.4
Mammoth	30	156.1	...	...	...	...	3.9	19.0	6.3	4.4	3.7	Failure		7.5

give the lowest yields. This is particularly evident when the data obtained from 1925-1930 are considered.

Columns 13 and 14 of Table 1 give the average yields in bushels of seed per acre for the 19 varieties grown from 1921-1930 and for all varieties for the years 1925-1930, respectively.

The extreme difference in average yield between any two varieties grown for the 10-year period is 7.3 bushels. When the average annual yields of Haberlandt and Peking are paired according to Student's method of calculating paired yields, it is found that extremely high odds (9999:1) in favor of Haberlandt are obtained. These odds are significant and are interpreted to mean that the difference in yield obtained in this experiment is due to a real difference in the yielding capacity of these two varieties and not to chance.

Haberlandt ranks first in yield of seed per acre with an average of 27.5 bushels. This is but slightly better than U. S. No. 36902, which has an average yield of 27.1 bushels. The difference of 0.4 bushel is not a significant difference.

Wilson, which was used as a check throughout this experiment, ranks eighth with an average yield of 25.4 bushels of seed per acre. This is 2.1 bushels less than Haberlandt and represents odds of 20:1 in favor of Haberlandt when calculated according to Student's method. The difference in capacity to yield between Haberlandt and Wilson varieties would probably not be considered a significant one since odds of approximately 30:1 are the generally accepted criteria of significance.

Most of the varieties that were grown only for the 6-year period are late-maturing sorts and this is reflected in the average yield of seed. The order of ranking of all varieties is changed but slightly when the 6-year average is compared with the 10-year average.

Table 2 contains data for yield in tons of air-dry hay per acre, as well as height and days to mature hay for the soybean varieties grown at Morgantown.

Column 2 shows that the average height of the varieties varies from 29.6 inches for Elton to 51.9 inches for Virginia. The taller varieties tend to show higher average yields of forage than the early, shorter varieties.

Column 3 shows the average number of days to mature hay. Elton is the earliest variety grown in the experiment, maturing hay in 87 days, while Chiquita and Peking were the latest maturing varieties in the 10-year and 6-year groups, maturing hay in 118 and 110 days, respectively. It is interesting to note that the varieties which give the heaviest forage yields are those which utilize the full period for growth and are thus considered relatively late types.

Columns 14 and 15 give the average yield in tons of air-dry hay per acre for the years 1921-1930 and 1925-1930, respectively.

Haberlandt with an average yield of 2.36 tons of air-dry hay per acre ranks first and averages about ¼ ton more than Peking, which ranks second with an average of 2.12 tons per acre. This difference is fairly consistent over the period of the experiment. Haberlandt

TABLE 2.—*Yield in tons of air-dry hay per acre, with height and days to mature, for hay of soybean varieties grown on the Agronomy farm*

Variety	West Virginia No.	Average Height in Inches	Ave. No. of Days to Mature Hay	Yield in tons of air-dry hay per acre										Ave. 1921-1930	Ave. 1925-1930
				1921	1922	1923	1924	1925	1926	1927	1928	1929	1930		
Haberlandt ...	5	37.1	105.3	2.53	2.58	2.22	3.06	2.69	2.41	1.74	2.63	2.15	1.63	2.36	2.21
Peking	11	44.1	110.0	2.42	2.24	2.42	2.10	1.93	2.20	1.48	2.50	2.17	1.72	2.12	2.00
Peking S. I-21-8	16	41.7	105.2	2.90	2.40	2.16	2.08	2.27	1.89	1.38	2.15	2.37	1.53	2.11	1.93
Mikado	7	35.9	108.1	2.25	2.05	2.12	2.10	1.97	2.49	1.54	2.49	2.37	1.57	2.10	2.07
Peking S. I-21-7	15	42.7	104.5	2.82	2.16	2.49	2.01	2.33	1.75	1.49	2.20	1.99	1.57	2.08	1.89
Peking S. I-21-5	14	42.4	105.0	2.73	2.40	2.28	2.09	2.21	1.80	1.30	2.16	2.26	1.48	2.07	1.91
Aksarben	23	33.1	101.9	2.16	2.06	2.09	1.96	2.20	2.62	1.50	2.06	2.17	1.67	2.05	2.04
Hamilton	19	32.6	102.6	2.13	2.06	2.33	2.21	2.21	2.44	1.31	2.15	1.98	1.37	2.02	1.91
Virginia	10	51.6	105.7	2.57	2.41	2.38	2.03	2.09	1.61	1.35	1.93	2.25	1.49	2.01	1.79
Wilson 89	1	39.9	100.1	2.30	1.99	2.31	2.13	2.02	1.73	1.29	1.98	2.56	1.54	1.99	1.85
Wilson I-21-9..	17	41.7	103.0	...	2.17	2.26	2.09	2.42	1.52	1.36	2.09	2.24	1.60	1.97	1.87
Wilson	9	38.8	100.2	2.39	2.46	2.17	2.01	2.10	1.67	1.39	1.99	1.98	1.42	1.96	1.76
Ohio 9016	18	29.7	100.2	2.31	1.97	2.07	2.09	2.14	1.97	1.26	1.90	1.89	1.61	1.92	1.79
Medium Green.	8	32.9	99.9	2.26	2.39	2.27	2.18	2.16	1.69	1.12	2.04	1.58	1.40	1.91	1.67
U. S. No. 36902.	26	31.1	91.9	2.42	2.02	2.03	1.77	2.10	1.69	1.10	1.77	1.50	1.43	1.78	1.60
U. S. No. 30745.	24	34.8	94.7	2.27	2.07	1.99	1.92	2.08	1.71	1.23	1.70	1.73	1.30	1.80	1.62
Manchu	4	34.2	88.0	2.13	2.02	1.94	1.84	1.86	1.62	1.14	1.84	1.67	1.54	1.76	1.61
Black Eyebrow	3	32.5	88.2	1.69	2.11	1.77	2.00	1.74	1.57	1.04	1.72	1.53	1.57	1.67	1.53
Elton	2	29.6	87.0	2.03	1.77	1.94	1.84	1.49	1.64	.68	1.57	1.23	1.21	1.54	1.30
Haberlandt 38 .	36	38.5	116.2	...	...	...	...	2.74	2.79	2.19	2.39	2.62	1.57	...	2.38
Laredo	45	40.7	123.0	...	...	...	...	2.37	2.66	1.69	2.29	2.68	1.58	...	2.21
Dixie	46	36.7	109.2	...	...	...	...	2.33	2.11	1.98	2.75	2.58	1.43	...	2.20
Chiquita	41	44.2	118.1	...	...	...	...	2.32	2.71	1.42	2.48	2.62	1.56	...	2.19
Morse	31	35.2	109.6	...	...	...	...	2.29	2.54	1.61	2.21	2.29	1.64	...	2.10
Lexington	39	33.9	112.2	...	...	...	...	2.28	2.63	1.58	2.42	1.92	1.61	...	2.07
Austin	34	34.3	109.6	...	...	...	...	2.02	2.24	1.71	2.21	2.16	1.65	...	2.00
Merko	38	36.3	103.3	...	...	...	...	2.37	1.78	1.47	2.48	2.06	1.40	...	1.93
Columbia	43	37.7	111.2	...	...	...	...	2.17	2.28	1.40	1.89	1.98	1.57	...	1.88
Mammoth	30	35.3	114.6	...	...	...	...	2.18	2.24	1.24	2.12	1.88	1.19	...	1.81
Hahto	42	29.3	116.0	...	...	...	...	1.39	2.36	1.58	2.55	2.05	1.21	...	1.86
Wilson-five ...	33	42.1	105.8	...	...	...	...	2.10	1.94	1.41	1.94	1.79	1.41	...	1.76
Hollybrook ...	29	33.6	105.0	...	...	...	...	2.07	1.64	1.03	2.05	1.65	1.11	...	1.59
Hoosier	44	30.7	92.3	...	...	...	...	1.85	1.62	1.23	2.75	1.60	1.38	...	1.74
Ebony	40	29.9	104.7	...	...	...	...	2.08	1.71	1.31	2.08	1.76	1.44	...	1.72
Midwest	37	30.0	104.8	...	...	...	...	1.93	1.75	1.10	2.06	1.53	1.12	...	1.58

produced more hay than Peking in seven of the ten years. In the three years in which Peking outyielded Haberlandt the differences in favor of Peking were small. Due to the fact that the differences in most years are in favor of Haberlandt, calculations by Student's method of pairing annual average yields give odds of 30:1. This 0.24 ton difference in yield between Haberlandt and Peking is a real difference in capacity to yield and is not due to chance fluctuations.

Wilson checks rank tenth in yield of air-dry hay per acre with an average annual yield of 1.99 tons. This represents an average annual yield of 0.37 tons less than Haberlandt. The calculated odds indicating this to be a real difference in yielding capacity of the two varieties are about 95:1 in favor of Haberlandt.

It is of interest to note that Haberlandt ranks first both in respect to seed and forage yields. Most of the soybean acreage grown in West Virginia is used for forage; therefore the matter of forage yield is very important to the grower in this state. Gross yield, however, should not be the only consideration, for the quality of the hay as reflected in coarseness of stalks and relative amounts of leaves is important from the standpoint of the grower.

Data recorded in column 15 of Table 2 give the average yields of all varieties between the years 1925-1930, inclusive. The yields range from 2.38 to 1.30 tons of air-dry hay per acre. These yields for the most part represent small differences for the varieties contained in the experiment. Unlike the yields for seed per acre given in Table 1, where the late maturing types were low in yield, Table 2 shows that the varieties giving greatest forage yields are those which utilize all of the growing period and thus come in the late-maturing group.

EXPERIMENTS AT THE LAKIN EXPERIMENT FARM

The experimental work at Lakin consisted of a comparative study of yields of forage and seed of certain varieties when grown in plots of cultivated rows and solid drill rows. In addition, eleven soybean varieties were grown at the Lakin Experiment farm during the years 1922-1929, while six of these varieties were grown from 1922-1930, inclusive. Plot size, arrangement, and method of obtaining yields at Lakin were similar to the methods used at the Agronomy farm at Morgantown, as previously described.

The varieties grown and the yield of seed in bushels per acre are listed in Table 3. The varieties are arranged according to their average yield in bushels per acre for the 8-year period for which comparable data are available. Hamilton ranks first with an average yield of 34.4 bushels of seed per acre, while Royal ranks lowest with an average yield of 26.6 bushels per acre. This difference in yield of 7.8 bushels represents a real difference in the yielding capacity of these two varieties.

Table 4 lists the varieties of soybeans grown at the Lakin Experiment farm in the order of their yield of air-dry hay in tons per

acre. Sherwood ranks first, Virginia second, and Haberlandt third with yields of 2.94, 2.91, and 2.89 tons, respectively.

It is of interest to note that the varieties that gave low yield of seed per acre are among the high producers of forage. Sherwood and Royal, tenth and eleventh in seed production, rank first and fourth, respectively, in yield of air-dry hay per acre.

Haberlandt, first in both seed and hay production at Morgantown, again demonstrated its capacity to yield when it ranked third in seed and forage yields at Lakin.

TABLE 3.—*Yield in bushels per acre of soybean varieties grown at the Lakin Experiment farm*

Variety	Yield in bushels per acre									Ave. 1922-1929	Ave. 1922-1930
	1922	1923	1924	1925	1926	1927	1928	1929	1930		
Ohio 9035 (Hamilton)	41.6	36.8	33.4	32.2	36.6	27.6	35.7	31.1	...	34.4	...
S. P. I. 36902	38.6	38.3	33.3	29.6	30.0	33.0	39.6	33.7	...	34.5	...
Haberlandt	38.2	35.4	30.2	31.9	32.2	30.3	36.6	31.2	29.1	33.2	32.8
Hollybrook	35.5	36.3	27.1	31.1	31.5	26.3	27.7	27.2	28.8	30.3	30.2
Peking I-21-7	31.5	36.1	28.5	27.2	31.0	26.9	38.5	32.5	28.3	31.5	31.2
Check (Wilson 89)	33.0	33.2	27.9	30.1	30.1	29.5	34.9	33.5	31.8	31.5	31.6
Virginia	33.1	31.7	28.1	30.4	30.5	26.7	32.2	31.4	29.3	30.5	30.4
Peking I-21-8	31.1	31.7	28.2	25.1	28.8	25.6	38.4	31.8	31.3	30.1	30.2
Md. No. 19186-B	26.2	28.7	27.8	31.1	29.7	26.6	29.5	32.7	...	29.0	...
Sherwood	27.9	26.0	24.7	29.6	28.6	20.3	31.4	30.7	...	27.4	...
Royal	26.6	19.3	22.7	28.8	26.5	25.4	31.2	32.3	...	26.6	...
Manchu	...	...	...	...	33.0	32.8	37.2	31.7	35.6	34.1	...
Midwest	...	...	...	...	29.5	20.9	30.5	27.7	24.3	26.6	...

TABLE 4.—*Yield in tons of air-dry hay per acre of soybean varieties grown at the Lakin Experiment farm*

Variety	Yield in tons of air-dry hay per acre									Ave. 1922-1929	Ave. 1922-1930
	1922	1923	1924	1925	1926	1927	1928	1929	1930		
Sherwood	2.80	2.87	3.14	2.78	2.82	2.57	3.59	2.92	...	2.94	...
Virginia	3.47	2.70	3.14	2.55	2.91	2.29	3.09	3.11	2.70	2.91	2.88
Haberlandt	2.82	2.75	3.10	2.91	3.15	2.42	3.23	2.76	2.78	2.89	2.88
Royal	2.98	2.73	2.99	2.45	2.57	2.38	3.24	2.65	...	2.75	...
Peking I-21-7	3.06	2.42	2.67	2.52	2.51	2.22	3.33	2.92	2.66	2.71	2.70
Hamilton	2.96	2.39	2.85	2.36	2.77	2.34	3.36	2.68	...	2.71	...
Md. No. 19186-B	2.90	2.96	2.86	2.48	2.63	2.02	2.93	2.66	...	2.68	...
Peking I-21-8	2.74	2.26	2.54	2.67	2.59	2.22	3.20	2.93	2.77	2.64	2.66
S. P. I. 36902	2.91	2.24	2.52	2.49	2.55	2.53	2.92	2.63	...	2.60	...
Check (Wilson 89)	2.74	2.33	2.64	2.28	2.39	2.07	3.18	2.83	2.71	2.56	2.57
Hollybrook	2.69	2.32	2.49	2.16	2.45	2.23	2.87	2.53	2.63	2.47	2.49
Manchu	...	...	...	...	2.32	2.29	2.99	2.49	2.66	2.55	...
Midwest	...	...	...	...	2.15	2.06	3.11	2.52	2.20	2.41	...
Mammoth Yellow	...	...	...	...	2.72	...	...	2.60	2.33	2.55	...

YIELD IN CULTIVATED ROWS AND SOLID DRILL ROWS

Bulletin 227 of the West Virginia Station gives the forage yields of Wilson soybeans obtained at Morgantown when grown in cultivated and solid drill rows. No significant difference was observed for the 5-year period during which this experiment was conducted.

The experiments at Lakin on the yield of cultivated and solid drill plots have been more extensive than the work at Morgantown. Three varieties of soybeans, Virginia, Peking Selection I-21-7, and Elton were compared for yield of forage over a 5-year period and compared for yield of seed for two years. Wilson variety was also included in the comparison for yield of seed.

The cultivated plots consisted of three rows, 30 inches apart and approximately 25 feet in length. Seeds were spaced approximately 1½ inches apart along the rows. About 1¾ feet were discarded from the end of the plot and the remainder of the center row was used in obtaining yields.

The solid drill plots were approximately 10½ feet x 25 feet gross and 8⅙ x 21½ feet net after removing the borders. The rate of seeding was 6 pecks per acre.

Both the solid drill plots and the cultivated row plots were planted in quadruplicate each year except in 1923, when there were eight cultivated row plots. In this year a solid drill plot occurred between each pair of cultivated row plots of the same variety. During the other years of the test the cultivated row plots were alternated with the solid drill plots of the same variety; or by another arrangement they were placed in close proximity to one another.

Table 5 gives the yield of air-dry hay in tons per acre for the three varieties during the period of this experiment. Yield differences, while not great, are fairly consistent in favor of the drill plots. When these differences are studied according to Student's method, odds are obtained in favor of solid drill over cultivated rows of 15:1, 10:1, and 38:1 for Peking Selection I-21-7, Virginia, and Elton varieties, respectively.

TABLE 5.—*Yield in tons per acre of air-dry hay of soybeans when grown in drill vs. row plats at the Lakin Experiment farm*

Year	Peking I-21-7		Virginia		Elton	
	Drill	Row	Drill	Row	Drill	Row
1923	2.79	2.52	3.18	2.74	2.24	2.07
1924	3.01	2.79	2.87	3.10	2.62	2.49
1925	2.29	2.43	2.69	2.47	2.20	2.14
1926	2.74	2.58	2.94	2.82	2.73	2.51
1930	3.13	2.59	2.99	2.53	2.79	2.60

TABLE 6.—*Yield in bushels of seed produced by solid drill and cultivated row plats for the year* 1927-1928

Year	Peking Sel. I-21-7		Virginia		Elton		Wilson	
	Drill	Row	Drill	Row	Drill	Row	Drill	Row
1927	29.4	28.3	32.0	27.9	31.4	29.7	26.9	27.2
1928	33.1	35.2	29.7	31.1	14.8	15.9	28.1	32.5

If the combined data for the three varieties are studied, the odds obtained are 458:1 in favor of solid drill over the cultivated row method of seeding. These differences although small are consistent and are fairly significant for the varieties studied in this manner. When P values are determined by the use of Fisher's application of Student's method, the odds are found to agree very closely with those given above.

Table 6 gives the data obtained in yield of seed produced by solid drill and cultivated row plots for the years 1927-1928. It is of

nterest to note that the yields obtained during 1927 show a decided dvantage in favor of the solid drill plots, whi'e the data for 1928 ndicate an equally favorable yield for the cultivated row plots. This vould seem to indicate that seasonal differences exert considerable nfluence on yield of seed. Since the available data cover but a two-'ear period, it is obvious that further investigations are necessary to)btain trustworthy data.

From a study of the data presented in this bulletin several facts .re observed which may be used in guiding one in the choice of 'ariety.

(1) The data indicate that soybean varieties may be divided into eed and forage groups. It is rather uncommon to find a single 'ariety that will excel in yield in both seed and forage.

(2) The choice of variety should be controlled by the use to be nade of the crop, whether for seed or hay.

(3) If the crop is to be grown for seed, a variety that will con-istently mature within the frost-free growing period should be :hosen.

(4) If the crop is to be grown for hay, one should choose a 'ariety which will give a high yield of a fine-stemmed, leafy forage, nd one the seed of which is easily available on the market.

(5) Haberlandt has demonstrated its ability to yield both seed nd hay under the conditions of this experiment. Although gross 'ield of forage is satisfactory, the quality of hay is very poor since he plants are coarse and stemmy.

(6) Most growers prefer varieties that will give a good yield of ine-quality hay and a fair seed yield. Such varieties as Peking Selection I-21-7, Wilson, or Peking may serve as a general purpose ype better than the higher-yielding Haberlandt. One of the chief easons for the popularity of the Wilson variety in this state is the lependability of the crop in producing a good-quality hay and a fair seed yield. The availability of Wilson seed in commercial amounts is nother factor that should have considerable influence in the choice of this variety.

DESCRIPTION OF VARIETIES

A description of the varieties which produced high average yields of hay and seed in the experiments may be of interest and aid to the grower in choosing the proper variety.

HABERLANDT: A late variety requiring 105 days to reach the proper stage for hay and approximately 145 days to mature seed. The plants are stout, erect, bushy, with medium-sized leaves that are somewhat leathery in texture. The stems are covered with a tawny pubescence. Flower color may be either purple or white. Seeds are rather large, straw colored, with a dark-brown hilum.

PEKING: This variety is an erect, fine-stemmed type requiring 110 days to reach the proper stage for hay and 144 days to mature seed. Plants have a tawny pubescence, with fine stems and abundant leaves. Flower color may be either purple or white. Seeds are

medium in size, somewhat f'attened, with black glossy seedcoat. This variety is widely grown for its desirable hay yields.

WILSON: This variety is erect, bushy, and fine-stemmed. In growth habit it is very much like Peking but under West Virginia conditions it will mature hay and seed about ten days to two weeks earlier than Peking. The seed is black and somewhat larger and fuller than Peking. Wilson is the most popular and widely grown soybean variety in West Virginia. Seed is readily available in commercial quantities and the yields of seed and hay are satisfactory and dependable.

PEKING SELECTION I-21-7: This pure-line selection was made at the West Virginia Station from the Peking variety. In yield of seed and forage it is very similar to Wilson but differs from Wilson in that the leaves are maintained until the plants are ready to harvest for seed.

HAMILTON: This is a stout, erect, bushy type of soybean which matures hay in 102 days and seed in approximately 140 days. Hamilton was introduced by the Ohio Station. The plants have a tawny pubescence, purple flowers, and large brown seeds with brown hilum. Hamilton produces rather coarse forage but has given satisfactory yields of seed and hay at Morgantown and at the Lakin farm.

SHERWOOD: A late-maturing variety with fine stems and many leaves. The plants have a gray pubescence with white flowers and yellow seed. This variety has given the best average yield of hay of all varieties tested at Lakin.

VIRGINIA: A late-maturing variety which requires 105 and 141 days to mature hay and seed, respectively. This is a very fine-stemmed variety with a tendency to vine. Hay is fine and generally of very good quality. The plants are covered with a tawny pubescence and produce purple flowers. Seeds are medium in size, flat, and brown in color. This variety is widely grown in certain regions of the United States and finds favor with many growers, particularly when grown with corn. Virginia has never given exceptional yields under West Virginia conditions.

SUMMARY

Thirty-five varieties and selections of soybeans were tested for yield of seed and hay on the Agronomy farm at Morgantown, and eleven varieties and selections were grown on the Lakin Experiment farm in Mason County.

The varieties giving good yields of hay as well as seed at Morgantown were Haberlandt, Peking Selection I-21-7, Peking, Wilson, and Hamilton.

Certain facts which may serve as a guide in the choice of varieties are enumerated, and seven of the more important varieties are briefly described.

Data are presented showing the relative yield of certain varieties when grown in cultivated vs. solid drill plats at the Lakin farm.

At Lakin Haberlandt, Hamilton, Sherwood, Virginia, and Peking I-21-7 gave the best yields of both hay and seed.